GEOLOGIC AND SEISMIC SAFETY ELEMENT OF THE GENERAL PLAN REPORT

POLICIES

IMPLEMENTATION PROGRAM

MAPS

CITY OF PINOLE
CALIFORNIA

ADOPTED BY CITY COUNCIL FEBRUARY 18, 1975
RESOLUTION NO. 1109

86 00569

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GEOLOGIC AND SEISMIC SAFETY POLICIES AND IMPLEMENTATION PROGRAM

PREFACE

Four basic methods of dealing with geologic and seismic problems exist. The first three are used to prevent an emergency through incorporating geologic information first, into long range land-use planning, second, through regulating development and third, through regulating construction. The last method is to deal with an emergency through disaster preparedness. It should be considered a short-term solution of the problem.

I. LAND USE PLANNING

Policies

a. Construction of emergency buildings, schools, theaters, meeting halls, and large apartment complexes should be discouraged in areas of major geologic problems, while agricultural and open space uses should be encouraged in these areas.

b. Intensity of development should be lowest in areas of many problems and highest in areas of few or virtually no problems.

Implementation

a. Keep the General Plan in agreement with seismic and geologic considerations.

Thus:

°The Land Use Element should recommend that, whenever possible, the most intensive uses should be located in the least hazardous areas.

°The housing section of the Land-Use Element should recommend that highest density housing be located in the least hazardous areas and vice versa.

°The Open Space Element should recommend that hazardous areas be zoned for open space use.

°The Circulation Element should recommend avoiding, whenever possible, designation as "major" traffic and utility lines which cross hazardous areas.

°The Safety Element should establish an earthquake disaster preparedness program (including ground shaking damage, ground failure damage, fire damage, and flooding damage).

b. Establish zoning in agreement with the element.

c. Incorporate geologic hazards information into redevelopment plans.

II. REGULATION OF DEVELOPMENT

Policies

a. Development proposals occurring in geologic problem areas should consider geologic factors when locating buildings, roads, utilities and parks.

b. Mitigating measures should be required to reduce the geologic risk to an acceptable level.

c. The location of the problem and potential problem areas should be a matter of public knowledge.

Implementation

a. Require geologic hazards studies. The studies should demonstrate that the property is suitable for the intended land use.

The depth of the studies will depend on the intensity of land use of the development and on the degree of risk accepted. Relatively high density residences might be located in the most stable areas, while the most unstable areas might be dedicated to open space. Cluster developments should adapt themselves to geologic considerations.

The city has been divided into study zones for each of the geologic and seismic hazards. A higher the study zone number assigned to a hazard indicates an increased geologic or seismic risk. Study zone numbers will be assigned according to the following list:

ZONE IV

- Fault Study Area IV
- Bay Muds Study Area IV

ZONE III

- Slope Stability Study Areas III
- Flood Prone Area III

ZONE II

- Fault Study Area II
- Alluvial Soils Study Area II

ZONE I

- Fault Study Areas I
- Slope Stability Study Areas I
- Alluvial Soils Study Area I
- Flood Prone Areas I

TYPES OF DEVELOPMENT	STUDY ZONES IV	III	II	I
Emergency Buildings	A	A	A	A
Public and/or High-use buildings	A	A	B	B
Commercial and Industrial buildings	A	A	B	B
Residential *	A	B	C	C
Recreational **	C	C	C	C
Agricultural **	C	C	C	C

A - Detailed study required

B - Reduced scope of study optional

C - Study optional (City staff decision)

* Requirements for geologic reports may be satisfied for a single 1 or 2 family residence if, in the judgment of City staff, sufficient information regarding the site is available from previous studies in the same area.
Exception: In Fault Study Zone IV, if the City staff finds that no undue hazard exists, geologic studies can be waived only after approval of the State Geologist.

** Buildings in these areas intended for human occupancy will follow the designation for Public and/or High-Use Buildings.

b. These Geologic Hazards Studies should be required to contain the equivalent of the information requested in the guidelines in the Geologic and Seismic Safety Supplementary Report. (Some flexibility of content is expected). The guidelines include five sections: Fault Displacement, Sliding, Liquefaction, Settlement, Flooding and Bay Muds. The studies include a regional review, a site investigation, conclusions, and recommendations (guided by minimum specific criteria). They must be prepared by a geologist and/or civil engineer registered in the State of California (as specified in the guidelines).

c. These studies, together with the soils/foundations investigations, should be incorporated into the Environmental Documents for consideration as an environmental issue pursuant to the Environmental Quality Act of 1970.

d. A qualified review system should be established for these reports. Two options are suggested:

° establish a citizens advisory committee of technical expertise (including, preferably, a geologist and an engineer registered in the State of California).

° in the process of preparation of Environmental Documents, establish a review of the Geologic Study by a geologist and an engineer registered in the State of California. At the time of filing of any Geologic Hazards STudy, a fee to cover adequate review will be charged.

e. A public education program for making the information found in these studies available to citizens in the community should be established.

The program might include a series of public talks or an informational booklet. Also, the possibility of requiring purchasers of land (and leasors) to sign a form stating that they are aware of the various special study designations of their property should be considered by legal staff. The level of risk acceptable is greater when people are aware of the risk.

III. REGULATION OF CONSTRUCTION

Policies

a. Those existing buildings susceptible to severe damage should be replaced or modified to minimize the ridk of damage.

b. The most modern building prictices available should be used in the design of buildings.

c. More effort should be placed in maximizing the structural safety of emergency buildings, schools, theaters, meeting halls, large apartment complexes and major public arteries, than in small residences and minor arteries.

Implementation

a. The Uniform Building Code is periodically revised to reflect changes and improvements in the state of the art of building design. Editions of these codes should be adopted within six months after they are published.

b. Existing hazardous buildings and parts of buildings (such as parapets) are now covered in the 1973 Uniform Building Code. A problem exists, however, with enforcement since most building inspection staff time is directed toward overseeing construction of new buildings. A program for periodically reviewing existing emergency, public and high-use buildings should be developed to determine which buildings are hazardous.

c. A program for repairing, vacating, or demolishing the hazardous buildings should be established (such as Vol. IV of the Uniform Building Code).

IV. EMERGENCY PREPAREDNESS

Policies

a. Plans should be made to deal with a possible geologic disaster so as to continue essential services during an emergency as part of the general Safety Element.

b. Such disaster preparedness should be considered as a mitigation of geologic hazards in preparation for a reduction of the geologic hazard problem. Thus, it only reduces the severity of the symptoms of geologic hazards, not the problem, itself.

Implementation

a. The public should be periodically educated as to what to do in an earthquake, flood, or other disaster.

b. The disaster preparedness program should be expanded by the City to more extensively include geologic-related disasters.

c. Earthquake insurance should be considered by all persons. Insurance can remove some of the risk of economic loss from property damage.

V. PROVISIONS FOR REVISION

a. Since people may become less tolerant of geologic risk in the future, changes in attitudes should be incorporated into the strength of the policies and standards of the City's General Plan.

b. One of the functions of Geologic Hazards Studies, as well as of Soils/Foundations Investigations and Environmental Impact Reports, is to provide additional basic geologic and soils data. This new information should be incorporated into the element by a person or firm hired by the City to review the Geologic Hazards Reports. They will also be able to waive studies when information from studies in neighboring areas warrant this action.

c. The Uniform Building Code sections pertaining to seismic design and dangerous buildings are periodically updated.

It is important that new codes be adopted soon after they appear. Also, new provisions in the Code relating to the Geologic and Seismic Safety Element should be incorporated into the element.

d. Engineering geology, geophysics, environmental geology, and seismic design are all rapidly advancing fields which are subject to rapid technical advances. The reviewing person or persons need to be familiar with these fields and their "state of the art" so that new advances can be incorporated into the General Plan.

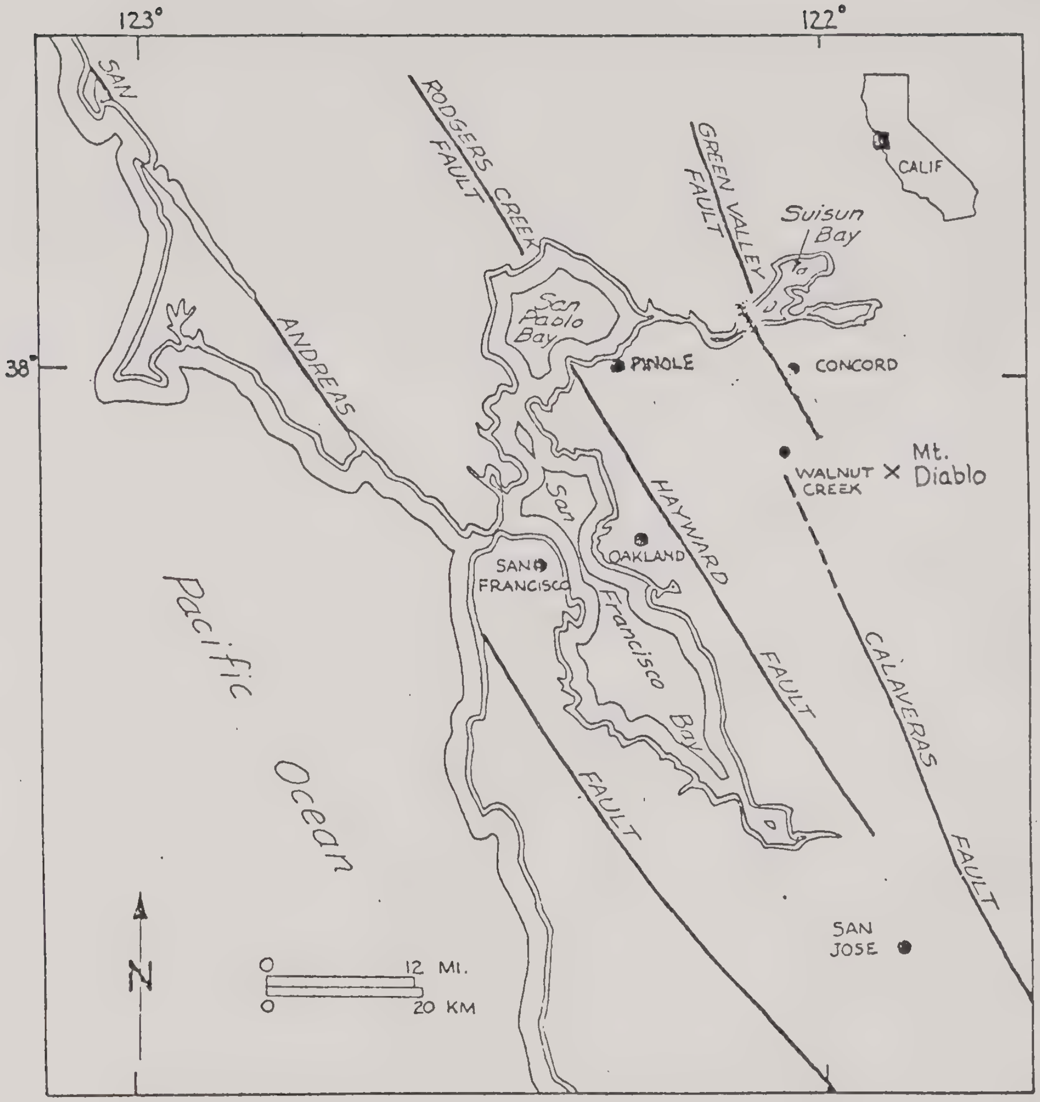

Figure 2: Faults Producing Ground Shaking *
(Known Active Faults or Active Portions of Faults)

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* Adopted from SHARP (1973)

GEOLOGIC AND SEISMIC SAFETY
SUPPLEMENTARY REPORT

CITY OF PINOLE
CALIFORNIA

ADOPTED BY CITY COUNCIL FEBRUARY 18, 1975
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APPENDIX A

GEOLOGIC HAZARDS STUDIES

Faults and Fault Displacement

Fault Definitions

Active Faults: These are faults which show evidence of movement during Holocene time (last 11,000 years). Evidence includes topographic or physiographic expressions suggestive of geologically young fault movements, fault creep, and/or records of surface rupture in historic time.

No known active faults are in the Pinole planning area. However, the San Andreas, the Hayward, and the Calaveras fault systems outside the planning area are considered active.

The westernmost fault in the Pinole planning area shown on Figure #1 has been classified as potentially active by the State Geologist and has, therefore, been placed in the special Alquist-Priolo Geologic Hazard Zone. A potentially active fault is one for which the evidence suggests fault displacement within the last 2-3 million years. The basis for the classification of the westernmost fault as potentially active is a report which suggests displacement of a geological unit which could be 2-3 million years old.

Faults of Uncertain Activity: There are faults which have no known evidence of movement during the last 2 to 3 million years, but there is a lack of information to adequately evaluate the fault[2] activity. Four faults within the planning area can be placed in this category.[2] The easternmost fault is probably inactive, although this is not known for certain.[3] However, these faults should not be considered inactive, active, or even potentially active until justified by geological investigations.

Inactive Faults: Inactive faults are those faults which can be shown not to have moved in the last 11,000 years.

The Hazard of Fault Displacement

Based on currently available evidence, the exact line along which a fault will break is impossible to predict at this time because of the uncertainties in (a) the exact location of the faults, (b) the exact fault trace along which the most recent ruptures have occurred, and (c) the width of the land which will be directly disturbed. The accuracy of fault mapping varies. Faults are dotted when concealed beneath recent soils. They are dashed when located approximately. When disagreements exist over whether or not a fault is present, question marks have been added.

Sources for the fault map (Figure 9) include: SHEEHAN (1956), COOPER, CLARK & ASSOC. (May 1971), SIMS, et al (1973), BURKLAND AND ASSOC. (1973), RADBRUCH & CASE (1967), PRELIMINARY SPECIAL STUDIES ZONES MAPS FOR THE MARE ISLAND AND RICHMOND 7-1/2' QUADRANGLES (1973), preliminary fault creep study undertaken by City staff, and CALIFORNIA DIVISION OF MINES AND GEOLOGY (1962).

Damage to structures above fault ruptures is related to the sense or direction, the amount, and the speed of movement. The sense of movement is noted on the maps as follows:

Vertical movement: U/D
U: ↑ upthrown side
D: ↓ downdropped side

Horizontal movement: ↗/↙
↗: direction of movement

If the Pinole Fault System were active and fault displacement were to occur along its entire length, it could generate a moderate size earthquake (magnitude[4] of 5.0 - 5.9). The displacement could result in horizontal movement and possibly minor vertical movement of several inches up to about one foot.

Ground Shaking and Ground Response

The San Andreas Fault can be expected to generate an earthquake of magnitude 7.0 to 7.9 once in every 100 years. The Concord and Hayward fault systems are capable of generating an earthquake of magnitude 6.0 to 6.9. These are the maximum probable 100 year earthquakes. The maximum credible earthquakes could be 8-1/2 for the San Andreas Fault and 7-1/2 for the Hayward Fault. For comparison, the San Francisco earthquake of 1906 had a magnitude of 8.3 and the San Fernando earthquake of 1971 had a magnitude of 6.6.

According to PAGE (1972), these magnitudes of earthquakes, at the distances of the faults from the planning area, could result in the following approximate values for acceleration and duration for bedrock.

Fault	Magnitude	Approx. Distance	Approx. Max. Bedrock Acceleration[5]	Duration[6]
San Andreas	7.0 - 7.9	18 miles	.5g	25 sec.
Hayward	6.0 - 6.9	3 miles	.9g	15 sec.
Concord	6.0 - 6.9	11 miles	.3g	10 sec.
Pinole	5.0 - 5.9	-	.5g	5-10 sec.

THESE VALUES ARE APPROXIMATE AND SHOULD BE CONSIDERED FOR INFORMATION PURPOSE ONLY AND SHOULD NOT BE USED FOR BUILDING DESIGN.

The estimated number of cycles (the number of times a uniform stress is applied) is roughly 30 for the San Andreas earthquake and 10 for the other earthquakes.[7] Again, these values are approximate only.

Ground Failure

Slides

Sliding is the result of the complex interaction of a variety of factors, most of which are listed below:

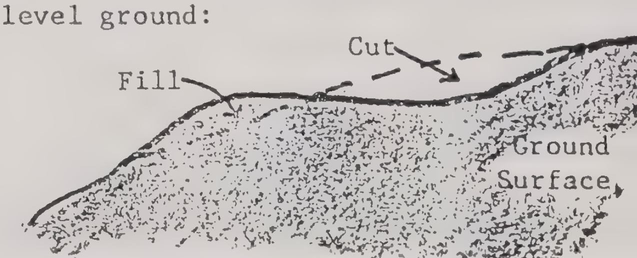
LESS LIKELIHOOD OF SLIDING

1. 0% of slope (level)
2. Dry materials
3. High strength materials such as firmly cemented sandstone which has not been severely sheared or fractured.
4. No faulting or jointing.
5. Materials have not been folded.
6. Climate characterized by a small amount of rainfall occurring in a long period of time.
7. Large amounts of vegetation containing deep roots.
8. Man has not influenced any of the above factors.

GREATER LIKELIHOOD OF SLIDING

1. Greater than 30% of slope (steep)
2. Water-saturated materials (can be due to springs)
3. Low strength materials such as surface soils and highly fractured shales with tuffaceous sands.
4. Many faults and/or joints present to provide a zone of weakness for failure and for springs.
5. Materials have been folded and areas occur where the slope is parallel to either the layers of rocks or the joints.
6. Climate characterized by a large amount of rainfall occurring in short period of time.
7. Small amounts of vegetation or no vegetation (after a fire, an area will temporarily be more prone to sliding.

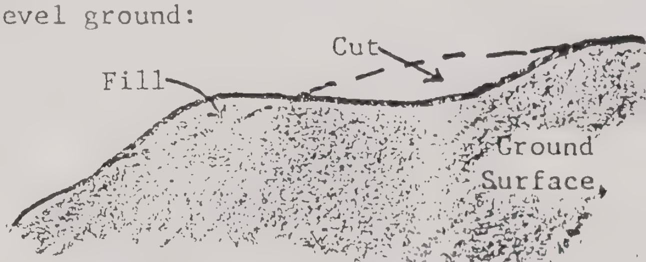
8a. Man has cut into slopes and added material to other slopes to achieve level ground:



or has modified the ground surface in some other manner.

b. Man has imported water to increase the wetness of the materials by watering lawns, irrigating, etc.

LESS LIKELIHOOD OF SLIDING	GREATER LIKELIHOOD OF SLIDING
1. 0% of slope (level)	1. Greater than 30% of slope (steep)
2. Dry materials	2. Water-saturated materials (can be due to springs)
3. High strength materials such as firmly cemented sandstone which has not been severely sheared or fractured.	3. Low strength materials such as surface soils and highly fractured shales with tuffaceous sands.
4. No faulting or jointing.	4. Many faults and/or joints present to provide a zone of weakness for failure and for springs.
5. Materials have not been folded.	5. Materials have been folded and areas occur where the slope is parallel to either the layers of rocks or the joints.
6. Climate characterized by a small amount of rainfall occurring in a long period of time.	6. Climate characterized by a large amount of rainfall occurring in short period of time.
7. Large amounts of vegetation containing deep roots.	7. Small amounts of vegetation or no vegetation (after a fire, an area will temporarily be more prone to sliding.
8. Man has not influenced any of the above factors.	8a. Man has cut into slopes and added material to other slopes to achieve level ground:



or has modified the ground surface in some other manner.

b. Man has imported water to increase the wetness of the materials by watering lawns, irrigating, etc.

c. Man has blocked existing drainages and has not provided for an alternative path for the water to follow.

d. Man has removed an overlying layer of impermeable material to expose an aquifer material to rainfall (causing increased water saturation and springs).

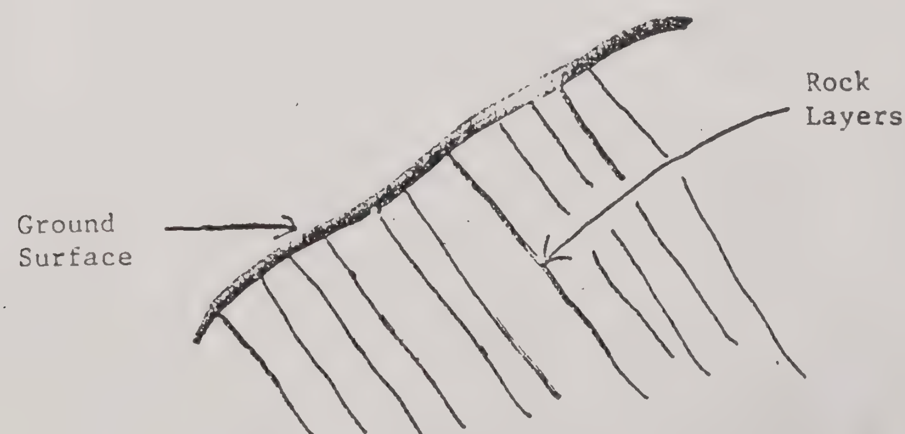
e. Man has removed vegetation.

Each of the above factors, exclusing man, was considered in the formulation of the risk areas. Data on each of these factors was obtained by analysis of geologic mapping[8], of topographic maps, of City of Pinole Public Works maps of "Slides and Uncompacted Fill Locations", of soils and foundation reports for subdivisions within the City, and of data obtained by field checking.

The more factors which are unfavorable in a particular area, and the greater the degree of the problem, the higher the risk for that area. In general, the relative importance of each of the factors remains the same with or without earthquake shaking. One exception is the possible increased importance of the degree of water saturation. Therefore, it is extremely beneficial to drain materials and to make sure that all possible steps are taken to prevent the rupturing of water-containing pipes which could release water to saturate new ground.

Figure 3 is not meant to replace individual site analysis in an engineering geology study. Rather, it is meant to indicate in a general way the relative slide risk.

Man's influence can occasionally decrease the risk in a particular area. For example, dewatering of materials through the establishment of a sophisticated drainage system or of deep-rooted vegetation can decrease the likelihood of a slide. Risks may be minimized by choosing localized areas where the materials are strongest and where the slope is opposite to the slope of the layers of rocks as shown.



FOOTNOTES:

1. Adopted from Armstrong (1973) (p. 76) and the definition of Potentially Active Faults on p. 3 of the Explanation of Special Studies Zones Maps compiled by the State Geologist.

2. Sources for this conclusion are: SHEEHAN (1956), a preliminary fault creep study undertaken by City staff, conversations with Darwin Myers (the geologist working for Contra Costa County), and Special Studies Zones Maps for the Richmond and Mare Island Quadrangles (1974).

3. Sources for this conclusion include those listed in (2) above and COOPER-CLARK & ASSOC. (May 1971).

4. Magnitude is a measure of the energy released by an earthquake. For one unit of increase in magnitude, the energy released increases between 30 and 60 times.

5. Given as fractions of g, the acceleration of gravity.

6. Duration is defined by Page (1972) as the amount of time between the first and the last accelerations equal or greater than .05 g.

7. Obtained from Darwin Myers, Contra Costa Planning Geologist.

8. SHEEHAN 91956) and SIMS, et al (1973).

APPENDIX B

INVESTIGATION OF BUILDINGS

The following charts list all of the emergency and public buildings and many of the high-use buildings in the City of Pinole. The information given in them served as a basis for the information on buildings contained in the Geologic and Seismic Safety Element of the General Plan.

EMERGENCY BUILDINGS:

	ADDRESS	YEAR BUILT	OCCUPANCY*	TYPE CONSTRUCTION**	NO. OF STORIES	FAULT STUDY AREA	SLOPE STABILITY STUDY AREA	FLOOD PRONE AREA
Doctors Hospital of Pinole	2151 Appian Way	1966	D-2 137 beds	T-I	1	I	III	I
City Office Complex	2121 - 2141 Pear Street	1967 1969	F-2 Approx. 30	T-IV	1	II	I	I
Firehouse	2170 Plum St.	1942	F-2 3 - 6 men on duty	T-V Stucco Ext.	1	II	I	I
Council Chamber Building	Pear Street	1920	B-3 Approx. 50	T-V Stucco Ext.	1	II	I	I

PUBLIC BUILDINGS:

	ADDRESS	YEAR BUILT	OCCUPANCY*	TYPE CONSTRUCTION**	NO. OF STORIES	FAULT STUDY AREA	SLOPE STABILITY STUDY AREA	FLOOD PRONE AREA
St. Joseph's School	1961 Plum St.	1961	C-1 9 Classrooms	T-V	1	II	I, III	I
Collins Elem. School	1224 Pinole Valley Road	1955	C-1 30 Classrooms	T-V	1	II	I	I
Pinole Jr. High School	Mann Dr. & Appian Way	1966	C-1 37 Classrooms	T-V, many portables	1	I	I, III	I
Shannon Elem. School	685 Marlesta Road	1966	C-1 20 Classrooms	T-V	1	IV	III	I
Stewart Elem. School	2040 Hoke Dr.	1962	C-1 16 Classrooms	T-V	1	I	III	I

PUBLIC BUILDINGS:

	ADDRESS	YEAR BUILT	OCCUPANCY*	TYPE CONSTRUCTION**	NO. OF STORIES	FAULT STUDY AREA	SLOPE STABILITY STUDY AREA	FLOOD PRONE AREA
Pinole Valley High School	2900 Pinole Valley Road	1967	C-1 70 classrooms	T-V Stucco Ext.	1	II	I	I
Ellerhorst Elem. School	3481 Pinole Valley Road	1960	C-1 20 classrooms	T-V	1	II	I	I
County Library Pinole Branch	2935 Pinole Valley Road	1974	B-2	T-III	1	II	I	I
Post Office	2102 Pear St.	1960	F-2 up to 24	T-III	Hall	II	I	I
Holy Ghost Hall	592 Tennent Ave.	1935	B-2	III	1	II	I	I
Eagles Hall	601 Tennent Ave.	1935	B-2	V	1	II	I	III

HIGH USE BUILDINGS:

	ADDRESS	YEAR BUILT	OCCUPANCY*	TYPE CONSTRUCTION**	NO. OF STORIES	FAULT STUDY AREA	SLOPE STABILITY STUDY AREA	FLOOD PRONE AREA
First Southern Baptist Church	530 Maiden Ln.	1966	B-3 135 seats sanctuary	T-V	1	I	III	I
Pinole Valley Baptist Church	2885 Pinole Valley Road	1970	B-3 300 seats sanctuary	T-V	1	II	I	I
Pinole United Methodist Church	2000 San Pablo Avenue	1963	B-3 300 seats sanctuary	T-V	1	II	III	I
St. Joseph's Church	837 Tennent Avenue	1950/ 1968	B-2 800 seats church	T-III	Hall and 2	II	I	I
Bayview Terrace Apartments	545 Sunnyview	1972	H 148 units	T-V Stucco Ext.	3 (parking under some)	I	III	I
Bonita Bay Apartments	585 Sunnview	1972	H 100 units	T-V Stucco Ext.	2&3 (parking under 1)	I	III	I
Casa Linda Apartments	2523 Henry Ave.	1962	H 12 units	T-V Stucco Ext.	3 (2 parking below)	II	III	I

HIGH USE BUILDINGS:

	ADDRESS	YEAR BUILT	OCCUPANCY*	TYPE CONSTRUCTION**	NO. OF STORIES	FAULT STUDY AREA	SLOPE STABILITY STUDY AREA	FLOOD PRONE AREA
East Bluff Apartments	1800 Marlesta Court	1972	H 144 units	T-V Stucco Ext.	2&3 (parking under some)	I	I, III	I
Knolls Apts.	801 Alvarez	1964	H 52 units	T-V Stucco Ext.	2	I	I, III	I
-	2171 Peach St.	1962	H 4 units	T-V Stucco Ext.	2 - park/part	II	I	I
-	2182 Peach St.	1969	H 4 units	T-V Stucco Ext.	2	II	I	I
-	1081 Tennent	1973	H 4 units	T-V Stucco Ext.	2	II	I	I
-	1061 Tennent	1972	H 4 units	T-V Stucco Ext.	2	II	I	I

* Uniform Building Code Group Classification

** Key to type Construction (ARMSTRONG, 1973, p. 149)

(T-1): Type I, all steel or concrete fire resistant construction

(T-2): Type II, similar to Type I, but with less fire resistance

(T-3): Type III, masonry walls with wood floors and roof

(T-4): Type IV, all light metal construction

(T-5): Type V, light wood frame construction

These Roman Numerals should not be confused with those indicating hazard study zones.

APPENDIX C

GUIDELINES FOR EVALUATING "GEOLOGIC HAZARDS STUDIES"

FAULT SECTION*

A. Regional Review

1. Location of the major or regional fault zones affecting the site being investigated. A discussion of the type, amount, and rate of displacement to be expected.

2. A review of the earthquake history of the area.

3. The above information can be obtained from a review of available reports and articles.

B. Surficial Site Investigation

1. Location of the fault trac(s) and those features normally related to present or past activity, such as sag ponds, alignment of springs, offset ridges, truncated spurs, dissected alluvial fans, scarps, alignment of landslides, and vegetation patterns, etc.

2. Location of the above relative to the proposed construction.

3. Estimation of the width of the fault zone within the project area.

4. Review of local ground water data such as water level fluctuation, ground water barriers, or anomalies.

5. The above information may be obtained from existing geologic maps, a study of aerial photographs, and a hydrologic data.

C. Specific Site Investigation

Depending on the results of Sections A and B, the City's geologic review staff may require a more specific site investigation. The additional data required may necessitate but not be limited to any or all of the following actions. The investigation will require original studies done specifically for the site.

D. Conclusions

1. Activity, potential amount and mode of surface displacement for any significant faults within or immediately adjacent to the site.

2. Delineation of those areas of highest geologic hazards.

3. The above information should reference supportive data stated in earlier sections.

* Modified from GRADING CODES ADVISORY BOARD, July 1973.

E. Recommendations

1. Recommended building restrictions or use limitations within any designated hazardous area that equal or exceed the following restrictions of the City regarding faults.

   a. No structure for human occupancy* shall be permitted to be placed across the trace of a potentially active fault in Study Zone IV unless it can be justified by a geological study and the provisions of the Alquist-Priolo Geologic Hazard Zones Act are followed. The area within fifty (50) feet (on either side) of a fault trace found in that zone shall be assumed to be underlain by branches of that fault unless and until proven otherwise by an appropriate geologic investigation and submission of a report by a geologist registered in the State of California.

   b. No emergency, public, large commercial, or apartment buildings, or any large subdivision residence shall be permitted to be placed astride the trace of any fault in Study Zone III.

2. These recommendations must be supported by and follow from the earlier conclusions.

F. Other Data

1. Sources of data.

2. Signature and license number of qualified geologist registered in California.

* A structure for human occupancy is one that is regularly, habitually, or primarily occupied by humans.

A. Regional Review

1. Identification of materials prone to liquefaction and settlement.

2. Review of the depositional environment at the site.

3. The above information can be obtained from a review of previously written reports and articles.

B. Site Investigation

1. Location and depth of materials prone to liquefaction, settlement, and lurching.

2. Elevation of water table.

3. This investigation will require original studies done specifically for the site.

C. Conclusions

1. Location of areas of liquefaction and/or settlement potential (if any) at the site and the location of the proposed construction.

2. Mitigating measures to reduce impact.

D. Recommendations

1. Recommended building restrictions or use limitations within designated potentially hazardous areas that equal or exceed the minimum restrictions of the City regarding liquefaction and settlement following:
   a. Areas of materials with liquefaction potential shall be mitigated.

   b. Emergency structures shall not be placed across the boundary between two material types with radically different foundation properties, unless sufficiently justified.

   c. Areas of loose sands which easily settle when shaken shall be mitigated or avoided.

2. These recommendations must follow from and be supported by the earlier conclusions.

E. Other Data

1. Sources of data.

2. Signature and license number of a qualified geologist registered in California and of a qualified civil engineer specializing in soils engineering registered in California.

FLOODING SECTION

A. Regional Review

1. Location of the major or reguinal stream channels affecting the site being investigated.

2. A review of the regional precipitation patterns, including amount, duration, frequency, and intensity of storms.

3. A review of the vegetation, construction, and slope (affecting run-off) in the drainage basin in interest.

4. A review of County Flood Control data.

5. The above information can be obtained from a review of previously written reports and articles.

B. Site Investigation

1. An examination of the stream channels affecting the site.

2. A statement explaining the results of 5, 10, 50 and 100 year floods.

C. Conclusions

1. Delineation of those areas with severe, moderate, and small flood potential.

2. The above should reference data stated earlier.

D. Recommendations

1. Recommended use limitations or flood control precautions that equal or exceed the minimum restrictions of the City regarding flooding following:

   a. No emergency, public, large commercial, or apartment building, or any major high-density subdivision residence shall be permitted to be placed in zone III without 100-year flood protection.

2. These recommendations must be supported by and follow from the earlier conclusions.

E. Other Data

1. Sources of data.

2. Signature and license number of a qualified civil engineer registered in California.

BAY MUDS SECTION

A. Site Investigation

1. Location of the bay muds and of fill overlying bay mud.

2. Location of the above relative to the proposed construction.

B. Conclusions

1. Delineation of those areas of highest geologic hazard.

2. The above information should reference supportive data stated in earlier sections.

C. Recommendations

1. Recommended building restrictions or use limitations within any designated hazardous area that equal or exceed the following minimum restrictions of the City regarding bay muds:

   a. All structures intended primarily for human occupancy shall avoid being placed on areas of bay muds or on fill overlying these muds unless justified by soils engineering reports.

D. Other Data

1. Sources of data

2. Signature and license number of a qualified civil engineer specializing in soils engineering registered in California.

GLOSSARY OF GEOLOGIC TERMS USED*

Active Fault: A fault which shows evidence of movement during Holocene time (last 11,000 years).

Alluvium: A general term for the sediments deposited in river beds, flood plains, lakes and estuaries during relatively recent geologic time.

Conglomerated: A sedimentary rock composed of larger pebbles or cobbles set in a matrix of finer materials (such as sand, silt, and/or clay).

Differential Subsidence: An occurrence in which two adjacent land areas subside by different amounts.

Earthquake: An event caused by the rapid snapping movement of rocks along a fault and producing ground shaking.

Expansive Soils: Clay-rich soils that greatly expand when wet and contract when dry.

Fault: A fracture (or break) in the earth along which the rock on one side has moved (or has been displaced) relative to the rock on the other side.

Fault Creep: A very slow movement along a fault which is unaccompanied by perceptible earthquakes.

Fault Trace: The intersection of a fault and the earth's surface.

Fault of Uncertain Activity: A fault which shows no known evidence of movement within the last 2-3 million years.

Flooding: A process in which excessive amounts of water during and after a storm are unable to be contained in existing natural drainage channels, and thus the water overflows into the valleys, or flood plains.

Geologic Hazards: Those natural processes which while altering the earth, present a threat to the health and safety of man, his property, and his community.

Geology: The science which studies the earth through studying the rocks of which it is composed, the fossils in these rocks, and the processes which alter it.

Ground Water Table: The upper surface of the zone of water saturation within the ground.

Ground Shaking: The shaking of ground due to an earthquake.

Ground Response: The manner in which earth materials vibrate in response to an earthquake.

Inactive Fault: A fault which is not active or potentially active.

Innundation: A type of flooding caused by the collapse of man-made dams or by the inadequacy of man-made drainage systems.

Intensity: A measure of the amount an earthquake is felt (see next page).

Liquefaction: A process by which a water-saturated sand layer loses strength when shaken, leading to a quicksand condition.

Magnitude: A measure of the energy released by an earthquake. For a one unit increase in magnitude, the energy released increases between 30 and 60 times.

Period: The time between seismic wave peaks.

Predominant Vibration Period: The time between seismic wave peaks to which a building on the ground is most vulnerable. (Usually measured in seconds).

Rock Structures: Those features of rocks produced in rocks by movements after deposition, such as folding of rock layers.

Sandstone: A sedimentary rocks formed from sands that have been cemented together.

Sedimentary Rocks: Rocks (commonly layered) formed by the accumulation sediments in water or from air.

Sediments: Particles of rocks, such as sand silt, and clay.

Seiches: Earthquake-caused waves in lakes.

Seismic: Pertaining to an earthquake or earth vibration, including those that are artificially induced.

Sensitive Soils: Fine-grained cohesive soils (clays such as San Francisco Bay muds) whose strength when shaken is far less than when undisturbed. (They are gelatin-like).

Settlement: The compaction of loose soils (may be associated with ground shaking).

Siltstone: A sedimentary rock composed largely of silt-sized particles

Shale: A sedimentary rock composed largely of clays that has developed fine layers.

Sliding: A perceptible downward movement of either wet or dry soil, or other earth materials, including rock.

Subsidence: A down-ward movement of land area, or a lowering of elevation of such an area.

Tertiary: A segment of geologic time beginning 70 million years ago and ending 3 million years ago.

Tuff: A rock formed from volcanic ash deposited in water on or dry ground

* Definitions of consultant, sometimes adapted from Armstrong (1973)

THE MERCALLI INTENSITY SCALE
(As modified by Charles F. Richter in 1956 and rearranged)

IF MOST OF THESE EFFECTS ARE OBSERVED:	INTENSITY IS:
Earthquake shaking not felt. But people may observe marginal effects of large distance earthquakes without identifying these effects as earthquake-caused. Among them: trees, structures, liquids, bodies of water sway slowly, or doors swing slowly.	I
Effect on people: Shaking felt by those at rest, especially if they are indoors, and by those on upper floors.	II
Effect on people: Felt by most people indoors. Some can estimate duration of shaking. But many may not recognize shaking of building as caused by an earthquake; the shaking is like that caused by the passing of light trucks.	III
Other effects: Hanging objects swing. Structural effects: Windows or doors rattle. Wooden walls and frames creak.	IV
Effect on people: Felt by everyone indoors. Many estimate duration of shaking. But they still may not recognize it as caused by an earthquake. The shaking is like that caused by the passing of heavy trucks, though sometimes, instead, people may feel the sensation of a jolt, as if a heavy ball had struck the walls. Other effects: Hanging objects swing. Standing autos rock. Crockery clashes, dishes rattle or glasses clink. Structural effects: Doors close, open or swing. Windows rattle.	V
Effect on people: Felt by everyone indoors and by most people outdoors. Many now estimate now only the duration of shaking but also its direction and have no doubt as to its cause. Sleepers wakened. Other effects: Hanging objects swing. Shutters or pictures move. Pendulum clocks stop, start or change rate. Standing autos rock. Crockery clashes, dishes rattle or glasses clink. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Structural effects: Weak plaster and Masonry D* crack. Windows break. Doors close, open or swing.	VI
Effect on people: Felt by everyone. Many are frightened and run outdoors. People walk unsteadily. Other effects: Small church or school bells ring. Pictures thrown off walls, knicknacks and books off shelves. Dishes or glasses broken. Furniture moved or overturned. Trees, bushes shaken visibly, or heard to rustle. Structural effects: Masonry D* damaged; some cracks in Masonry C*. Weak chimneys break at roof line. Plaster, loose bricks, stones, tiles, cornices, unbraced parapets and architectural ornaments fall. Concrete irrigation ditches damaged.	VII

IF MOST OF THESE EFFECTS ARE OBSERVED:	INTENSITY IS:
Effect on people: Difficult to stand. Shaking noticed by auto drivers. Other effects: Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Furniture broken. Hanging objects quiver. Structural effects: Masonry D* heavily damaged; Masonry C* damaged, partially collapses in some cases; some damage to Masonry B*; none to Masonry A*. Stucco and some masonry walls fall. Chimneys, factory stacks, monuments, towers, elevated tanks twist or fall. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off.	VIII
Effect on people: General fright. People thrown to ground. Other effects: Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes. Steering of autos affected. Branches broken from trees. Structural effects: Masonry D* destroyed; Masonry C* heavily damaged, sometimes with complete collapse; Masonry B* is seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frames racked. Reservoirs seriously damaged. Underground pipes broken.	IX
Effect on people: General Panic. Other effects: Conspicuous cracks in ground. In areas of soft ground, sand is ejected through holes and piles up into a small crater, and, in muddy areas, water fountains are formed. Structuarl effects: Most masonry and frame structures destroyed along with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes and embankments. Railroads bent slightly.	X
Effect on people: General panic. Other effects: Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Structural effects: General destruction of buildings. Underground pipelines completely out of service. Railroads bent greatly.	XI
Effect on people: General panic. Other effects: Same as for Intensity X. Structural effects: Damage nearly total, the ultimate catastrophe. Other effects: Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.	XII

*Masonry A: Good workmanship and mortar, reinforced designed to resist lateral forces.
Masonry B: Good workmanship and mortar, reinforced.
Masonry C: Good workmanship and mortar, unreinforced.
Masonry D: Poor workmanship and mortar and weak materials, like adobe.

(ARMSTRONG, 1973)

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APPENDIX G

ALQUIST-PRIOLO GEOLOGIC HAZARD ZONES ACT*

PUBLIC RESOURCES CODE

CHAPTER 7.5. HAZARD ZONES

2621. This chapter shall be known and may be cited as the Alquist-Priolo Geologic Hazard Zones Act.

2621.5. It is the purpose of this chapter to provide for the adoption and administration of zoning laws, ordinances, rules, and regulations by cities and counties, as well as to implement such general plan as may be in effect in any city or county. The Legislature declares that the provisions of this chapter are intended to provide policies and criteria to assist cities, counties, and state agencies in the exercise of their responsibility to provide for the public safety in hazardous fault zones.

2622. In order to assist cities and counties in their planning, zoning, and building-regulation functions, the State Geologist shall delineate, by December 31, 1973, appropriately wide special studies zones to encompass all potentially and recently active traces of the San Andreas, Calaveras, Hayward, and San Jacinto Faults, and such other faults, or segments thereof, as he deems sufficiently active and well-defined as to constitute a potential hazard to structures from surface faulting or fault creep. Such special studies zones shall ordinarily be one-quarter mile or less in width, except in circumstances which may require the State Geologist to designate a wider zone.

Pursuant to this section, the State Geologist shall compile maps delineating the special studies zones and shall submit such maps to all affected cities, counties, and state agencies, not later than December 31, 1973, for review and comment. Concerned jurisdictions and agencies shall submit all such comments to the State Mining and Geology Board for review and consideration within 90 days. Within 90 days of such review, the State Geologist shall provide copies of the official maps to concerned state agencies and to each city or county having jurisdiction over lands lying within any such zone.

The State Geologist shall continually review new geologic and seismic data and shall revise the special studies zones or delineate additional special studies zones when warranted by new information. The State Geologist shall submit all such revisions to all affected cities, counties, and state agencies for their review and comment. Concerned jurisdictions and agencies shall submit all such comments to the State Mining and Geology Board for review and consideration within 30 days. Within 30 days of such review, the State Geologist shall provide copies of the revised official maps to concerned state agencies and to each city or county having jurisdiction over lands lying within any such zone.

* As created by Senate Bill No. 520, December 22, 1972 and amended by Senate Bill No. 2422, September 26, 1974.

HAZARD ZONES (Continued)

2623. Within the special studies zones delineated pursuant to Section 2622, the site of every proposed new real estate development or structure for human occupancy shall be approved by the city or county having jurisdiction over such lands in accordance with policies and criteria established by the State Mining and Geology Board and the findings of the State Geologist. The State Geologist shall, by regulation, define "new real estate development" and "structure for human occupancy" for the purposes of this chapter; provided, however, that a new real estate development shall include a subdivision as defined in the Subdivision Map Act (commencing with Section 11500, Business and Professions Code). Such policies and criteria shall be established by the State Mining and Geology Board not later than December 31, 1973. In the development of such policies and criteria, the State Mining and Geology Board shall seek the comment and advice of affected cities, counties, and state agencies. Cities and counties shall not approve the location of such a development or structure within a delineated special studies zone if an undue hazard would be created, and approval may be withheld pending geologic and engineering studies to more adequately define the zone of hazard. If the city or county finds that no undue hazard exists, geologic and engineering studies may be waived, with approval of the State Geologist, and the location of the proposed development or structure may be approved.

2624. Nothing in this chapter is intended to prevent cities and counties from establishing policies and criteria which are stricter than those established by the State Mining and Geology Board, nor from imposing and collecting fees in addition to those required under this chapter.

2625. (a) Each applicant for a site approval for a new real estate development or structure for human occupancy within a delineated special studies zone shall be charged a reasonable fee by the city or county having jurisdiction over the proposed development or structure.

(b) Such fees shall be set in an amount sufficient to meet, but not to exceed, the costs to local government of administering and complying with the provisions of this chapter.

(c) The geologic and engineering studies specified in Section 2623 shall be in sufficient detail to meet the criteria and policies established by the State Mining and Geology Board for individual parcels of land.